VOLUME XXXIV NUMBER 2 WHOLE NUMBER 291

THE JOURNAL

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR, C. A. CHANT ASSISTANT EDITOR, F. S. HOGG
David Dunlap Observatory
Richmond Hill P.O., Ont.

ASSOCIATE EDITORS
R. MELDRUM STEWART
Dominion Astronomer
Ottawa

W. E. HARPER
Director of the Dominion Astrophysical Observatory
Victoria, B.C.

J. PATTERSON
Controller of the Meteorological Service of Canada, Toronto

PUBLISHED MONTHLY
(*Ten numbers per year*)

February, 1940

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XXXIV, No. 2 FEBRUARY, 1940 WHOLE No. 291

Articles PAGE

The Variability of ζ Herculis ..... *William Petrie* 41

Shakespeare and the Stars ..... *S. W. Dyde* 49

Meteors ..... *A. V. Madge* 57

Sixty-third Meeting of the A.A.S., December 1939 ..... *P. M. Millman* 67

Notes and Queries

Making a Virtue of Necessity—When the Earth Split—Stourbridge Fair, Newton's Prism (*C.A.C.*) 77

Meetings of the Society

At Victoria—At Edmonton 79

Upon request, made previous to publication of article, contributors will be supplied free with twenty-five copies of the sheets containing the article attached to a printed cover.

If separate reprints are desired the cost will be about as follows:

	4 pp.	8 pp.	12 pp.	16 pp.	20 pp.	24 pp.
50 copies....	$3 50	$5 50	$9 50	$10 00	$13 00	$16 00
100 copies....	4 00	7 00	10 00	11 00	14 00	18 00
200 copies....	4 50	8 00	11 00	12 00	15 50	20 00

Covers, extra, 50 copies, $1.50; 100 copies, $2.00; 200 copies, $2.50.

Business correspondence, remittances, etc., should be addressed to J. H. Horning, Treasurer of the Society, 198 College Street, Toronto.

Communications regarding Library matters should be addressed to the Librarian.

$2.00 per annum. Single numbers, 25 cents.

Subscription to the JOURNAL is included in membership fee.

For Sale—6-inch Newtonian Reflecting Telescope (see illustration in this JOURNAL page 341, October 1939.) This telescope with aluminised mirror, duraluminum tripod and altazimuth mounting, weighs only 35 lbs. Eyepieces with 50x and 100x magnification. A highly accurate, well finished, but very inexpensive telescope. Produced and sold by the Shaw-Hopkins Laboratory, Victoria, B. C.

PRINTED IN CANADA

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

Vol. XXXIV, No. 2 FEBRUARY, 1940 WHOLE No. 291

THE VARIABILITY OF ι HERCULIS

By WILLIAM PETRIE

STANDARD velocity stars have engaged the attention of numerous observers and they are important objects in all radial velocity work. A standard velocity star, of course, is just what the name implies, one that does not exhibit any velocity variation. When a known or suspected variable star is being observed for radial velocity, one should obtain spectrograms of a constant velocity object for each night that the star is observed. If the spectrogram of a constant velocity object reproduces the accepted value of the velocity within the errors of measurement, then the observer can be sure that any velocity variation found in the star under investigation is not due to errors introduced by the spectrograph or method of measurement. It is necessary then, that the star used for comparison should be a true standard velocity object, and every precaution should be taken to make sure that such is the case. For this reason it was felt that the star ι Herculis, which has been the subject of numerous investigations, should have an extensive series of radial velocity measurements with high dispersion.

Prior to 1932, radial velocities of ι Herculis had been published by observers at the Yerkes,[1] Dominion,[2] Lick[3] and Dominion Astrophysical[4] Observatories. The star was recommended as a standard velocity object by the International Astronomical Union,[5]

[1] *P. Yerkes O.*, **2**, 235, 1903 and *Ap.J.* 64, 15, 1926.
[2] *P. Dom. O.*, **5**, 345, 1921. [3] *P. Lick O.*, **16**, 258. 1928,
[4] *P. Dom. Ap. O.*, **5**, 142, 1931.
[5] *Trans. I.A.Un.*, **4**, 181, 1932.

although an appreciable velocity range appeared in the published results of the various observatories, the mean maximum and minimum velocities being -25.1 km/sec., and -14.3 km/sec. respectively. The adopted standard velocity was -18.0 ± 0.6 km/sec. It should be mentioned that the Ottawa results were considered by Henroteau[2] to suggest the possibility of a short period variation in approximately 0.4 days.

More recent observations have cast further doubt upon the suitability of this star as a velocity standard. In 1934 Marshall[6] called attention to the fact that the Michigan observations indicated a variation in the velocity, and he suggested the possibility of a long period. Edwards[7] in 1937 observed the star in order to investigate spectral line intensities, using a visual wedge photometer. He derived the intensity ratio for the lines λ 4388 of helium, and λ 4481 of ionized magnesium, and found this ratio to be variable within a small range. He derived a period of 0.1434 days for this variation, and concluded that the star was a *β Canis-Majoris* type variable. The characteristics of this type of variable are, briefly, (*a*) a very short period for the radial-velocity radiation, (*b*) a parallel variation in light, (*c*) a change in amplitude, and sometimes form, for the light and radial-velocity curves, (*d*) the width and intensity of spectral lines vary in a constant period almost the same as the period of velocity variation.

In order to test Edward's suggestion, Heard[8] secured a series of single-prism spectrograms during one night, covering an interval of six hours. From these he measured radial-velocity and spectral-line intensities, and found that neither exhibited any variation greater than the errors of measurement.

These investigations may be summarized as follows: the velocity range is too great to be laid to errors of measurement, since the spectral lines are sharp and sufficiently numerous to yield reliable results.

Soon after the publications of Edward's[7] article, the writer, through the courtesy of Dr. Harper, director, and members of the observatory staff, was able to study observations of ι Herculis with high dispersion. The objects in view in this investigation were

[6] *P.O. Univ. Mich.*, **5**, 166, 1934.
[7] *M.N.*, **97**, 99, 1937.
[8] *P. Amer. A. Soc.*, **9**, 155, 1939.

(i) to determine whether the radial velocity was constant or variable, (ii) to examine whether the velocity, if variable, agreed in its variation with Edward's short period, (iii) to determine spectral-line profiles in order to measure their variation, if any should exist.

The Observations. Observations were begun on June 30, 1937, and were continued until August 13, 1939, fifty-two spectra being secured in all. In order to test for a short period variation, a series of ten plates was secured on May 7, 1939, covering an interval of 0.195 days, and a second series was obtained on May 12, containing six plates covering an interval of 0.154 days. In order to give a firmer basis for establishing the reality of velocity variations, standard velocity stars were usually photographed just before or after exposure upon ι Herculis. The spectrograms obtained were all of high dispersion, *xxx* angstroms per mm. at λ *xxxx*, consequently there can be little doubt but that the measured velocities are accurate.

The Radial Velocities. The spectrograms were measured for radial velocity in the usual manner, all the plates being measured on the projection micrometer.[9] In order to render the velocities as homogeneous and precise as possible, only the best defined lines were used, and these were measured on practically every plate, except for a few spectra which were underexposed at the *K* region. The average probable error of a plate derived from the internal agreement of the individual lines is ±0.8 km/sec. Seventeen plates of standard velocity stars were measured and, although in some instances the number of lines measured is too small to give velocities of the highest precision, in every case the agreement with the adopted standard velocity is sufficiently good to show that the observed variation in ι Herculis cannot be ascribed to errors introduced by the spectrograph. A complete tabulation of the velocity measures will appear elsewhere.

The results indicate that ι Herculis is undoubtedly a velocity variable with a range of approximately 15 km/sec. and a mean velocity of −21.1 km/sec. The range is too great to be ascribed to errors of measurement, when one considers the well-defined nature of the lines, and the fact that the spectrograms were of high dispersion. After the 1938 observations commenced, it became

[9] *J. Roy. A.S. Can.*, **31**, 389, 1937.

apparent that this star was not a suitable standard velocity object and a recommendation to that effect was made to the International Union.[10]

The individual radial velocities for the nights May 8 and May 12, 1939, are listed in the table, and are shown plotted against time (Julian Day) in figure 1. An inspection of the table and figure

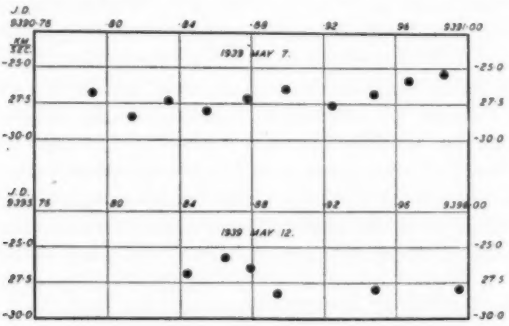

Fig. 1.—Radial Velocities of ϵ Herculis during single nights.

shows that the series of plates made on May 7, 1939 gives substantially a constant velocity, and the same is true of the series on May 12, 1939. During the former night, ten plates covering an interval of four hours and forty minutes, exhibited a total range of 3.0 km/sec., while on the latter night, six plates covering an interval of three hours and forty minutes, showed a total range of 2.6 km/sec.

It appears then, that a period of a few hours as suggested by Henroteau, and also by Edward's results on spectral line intensities, is ruled out by these observations. On the other hand a long period, as suggested by Marshall,[6] is apparently ruled out by the 1938 observations, which show a variation of 14 km/sec. in an interval of twenty-eight days. Efforts to find a period for the Victoria observations have so far proved unsuccessful, but it should not necessarily be concluded that a period does not exist, since the small range in velocity makes a decision difficult.

The velocity variations have also been examined by Schles-

[10] *Trans. I.A. Un.*, **6**, 258, 1938.

OBSERVATIONS OF ι HERCULIS DURING THE NIGHTS OF MAY 7 AND MAY 12, 1939

Date	Radial Velocity km/sec.	Intensity Ratio 4388/4481	Date	Radial Velocity km/sec.	Intensity Ratio 4388/4481
May 7, 1939	−26.7	3.6	May 12, 1939	−26.8	3.3
	−28.4	3.0		−25.7	2.7
	−27.4	3.0		−26.5	3.4
	−27.9	3.9		−28.3	—
	−27.2	3.4		−28.0	—
	−26.5	2.6		−28.0	—
	−27.6	3.6			
	−26.8	3.5			
	−25.9	3.1			
	−25.4	3.5			

inger's[11] criterion for spectroscopic binaries. This method is so instructive that it is worth while to mention it briefly here. The total range exhibited by the measured velocities is divided into equal groups, say 2 km. each, and the number of velocities that fall within each group is counted. Considering these numbers as ordinates, and the mean velocity of each group as abscissae, points are plotted and joined by a smooth curve, which is the frequency-curve for these velocities. Next the shape of this curve is compared with the familiar error curve, and if the two are reasonably alike it may be concluded that the observed velocity-range is accidental and that the star is not variable in velocity. On the other hand, if the object is a true binary, undergoing elliptic motion, then the frequency curve has one of several definite forms which depend upon the orbital eccentricity and orientation. From an inspection of the observed frequency-curve for a suspected variable one may therefore decide whether the velocity range is real, and, if so, infer certain characteristics of the orbit. The observed frequency-curve for ι Herculis is shown in figure 2, together with that of the normal error curve (broken line) and it is seen at once that, according to the criterion, the frequency-curve indicates that the variation in velocity is real and not due to errors of measurement.

Line Residuals. In a star suspected of velocity variation of the kind given by *β Canis Majoris*, it is of interest to study the velocities

[11] *Ap. J.*, **41**, 162, 1915.

given by individual lines. Although the spectral lines in this star are well defined, a considerable range in individual line velocities is found. The differences are of a systematic nature, and persist in

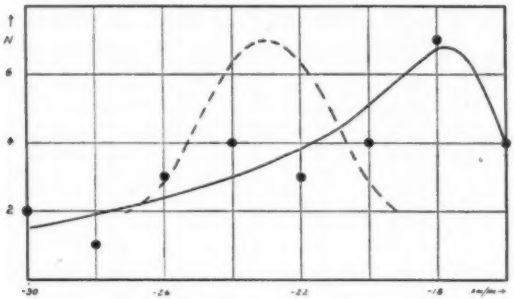

Fig. 2.—The frequency curve for the radial velocities of ι Herculis. The number of observations in a given velocity interval is plotted against the mean velocity of the interval (abscissae). The full curve illustrates the course of the observed frequency curve while the broken line gives the distribution to be expected if the velocity range were due to accidental errors.

such a way as to leave no doubt as to their reality. It was found that with one exception, the helium lines have positive residuals with respect to those of the hydrogen and metallic lines, the mean difference amounting to +3.4 km/sec. This difference is equivalent to 0.05 angstrom units, and is not likely to be due to incorrect wavelengths. An explanation is suggested by recent work of Foster and Miss Douglas[12] on the Stark effect in stellar spectra. These writers show that the lines of neutral helium are affected by electric fields in such a way as to cause them to be displaced towards longer wavelengths. They find evidence for the presence of an electric field in ι Herculis from line-profile studies, and additional evidence is supplied by the general tendency of the measures in this paper to show positive residuals for the helium lines. It may be mentioned that a search for short period variations in the line residuals from the ten spectra of May 7, did not show any periodicity in the interval covered by these observations.

[12] *M.N.*, **99**, 150, 1939.

Spectral Line Profiles. Edwards' observations, as noted, referred to measures of line intensity made with a visual wedge. Specificially the ratio of intensities for λ4388 HeI and λ4481 MgII was used, and defined a period of 0.1434 days. In order to study this effect, it was decided to determine line profiles for several spectral lines, especially for that series of ten plates made on May 7, 1939. The plates were analyzed with the self-recording microphotometer, and the tracings were reduced to give line profiles in the usual manner, the plates having been calibrated in a spectrograph, using a rapidly rotating sector before the slit. The lines Hγ, λ4388 and λ4471 of helium and λ4481 of ionized magnesium were measured, and the intensity ratios for 4388/4481 are given in

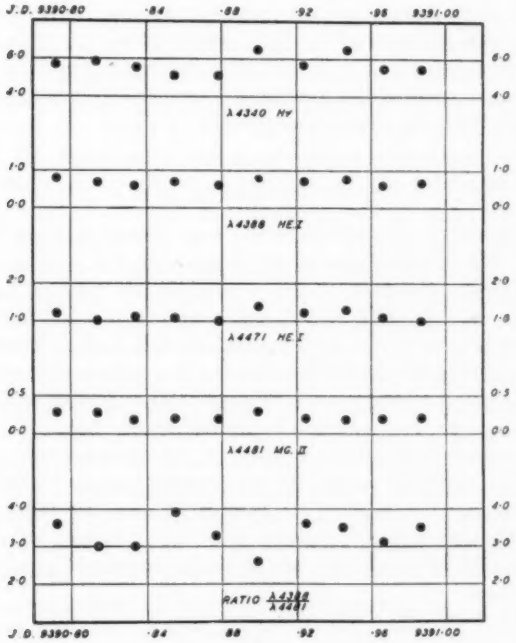

Fig. 3.—Intensities of Spectral Lines in ι Herculis during the night of May 7, 1939.

the table. The total absorption results for the ten plates of May 7 are plotted against time in figure 3.

The observations of line intensity show considerable scatter, and it is clear from figure 3 that there is no definite tendency for the observations to fit a periodic variation of a few hours. This conclusion is confirmed when one considers the results of additional measures. It is difficult to say definitely whether the scatter represents a real change, or is simply a result of the inevitable errors due to the uncertainty in drawing the line wings upon the tracings. Since the absorption lines are not intense, with the exception of Hγ which shows the least percentage scatter, the writer is inclined to view this range in values as being accidental. This conclusion is in agreement with Heard's results based upon single-prism spectra, from which he determined line profiles. The periodic variation in line intensity announced by Edwards is hence not shown by the data of this paper. A more detailed description of these and the above observations will appear in a forthcoming Publication of the Dominion Astrophysical Observatory.

Summary

The results of this investigation may be summarized briefly as follows: (i) ι Herculis varies in radial velocity over a range of approximately 15 km/sec., and should not be used as a standard velocity star. (ii) The radial velocities do not exhibit a short period variation of the kind typical of a *β Canis Majoris* star. (iii) The ratio of line intensities does not, according to these observations, vary in a period of 0.1434 days, and it is doubtful whether any real change in absorption is present in the data.

In concluding this brief account of the spectroscopic studies of ι Herculis, the writer wishes to express his thanks to Dr. Harper for his kindness in making it possible for him to undertake this study. He also wishes to acknowledge the guidance and assistance of Dr. R. M. Petrie, who secured and measured many of the spectrograms.

Dominion Astrophysical Observatory,
Victoria, B.C.,
December, 1939.

SHAKESPEARE AND THE STARS*

By S. W. Dyde

FOR me to write a paper on *Shakespeare and the Stars* for an Astronomical Society is worse than seeking to carry coals to Alberta, a work of supererogation. To avoid the guilt of that absurdity I must adhere closely to the subject of my title, which is Shakespeare's attitude to the astronomy and astrology of his day.

To begin with I might refresh your minds with a few dates. Shakespeare was born in 1564. Galileo was born in the same year. Copernicus, a contemporary of Luther, died 21 years before that date. Kepler published his work on the motions of Mars in the year 1609, when Shakespeare's literary life was drawing to a close. From these dates it might almost be inferred that in Shakespeare's day the Ptolemaic view of the heavens was still in vogue, but that the Copernican theory was slowly making its way amongst students of the sky. In was, in fact, rejected by Francis Bacon in 1612. By Milton's time (1608-1674) it had become more widely known, although it had not, perhaps even then, caught the general imagination. All the references to the stars which I have found in Shakespeare are more or less directly connected with the Ptolemaic system, which had been universally taken for granted from the 2nd Century A.D. to the middle of the 16th.

Shakespeare, we must not allow ourselves to forget, had his intellectual home in the theatre. He was himself an actor, and his friends were playwrights and actors. When he burned the midnight oil, as he often did, he was poring over the works of his predecessors in the drama,—Kyd, Marlowe, Greene and Peele—and over the works of the poets Chaucer and Spenser. He made a study of tragedies of Seneca both in Latin and in English. He delved into the chronicles of Holinshed and the *Lives* of Plutarch. He has been thought by some commentators to have had a training in law, or again to have studied medicine or mental diseases, or again, to have travelled on the continent. None of these guesses, though possible, is at all probable.† His wide knowledge is almost certainly due to

* A paper given to the Edmonton Centre, 14 Dec. 1939.

†The January number of the *Scientific American* contains an interesting article on the possible identification of William Shakespeare as Edward deVere, 17th Earl of Oxford, based on recent x-ray and improved studies of accepted contemporary paintings of the author.—Editor.

the unremitting toil of a Gargantuan mind. Owing to the alertness and penetration of his imagination he found material for his plays where others found none; he was always a snapper-up of unconsidered trifles. While he worked hard, he had his hours of relaxation with his fellow craftsmen at the Mermaid Inn.

In his own reading and in his encounters with the University wits he picked up all the astronomy he ever knew. He made, so far as I can see, not a single investigation or connected observation. For him, as for imaginative minds in general, the heavens were a thing of beauty and wonder.

> Hark, hark, the lark at heaven's gate sings
> And Phoebus 'gins arise. (*Cym.*)

> O setting sun
> As in thy red rays thou dost sink to night. (*J. C.*, V, 3)

One could fill pages with such quotations. Nor did our poet find any difficulty in absorbing the mythological lore of Greece and Rome. His works are thickly strewn with references to the gods and heroes of earth and sky. They helped to embody and enhance his conception of the significance and the mystery of human life.

From what has been said it will be assumed that whatever scattered references there are in Shakespeare to the stars, they will reflect the Ptolemaic system. Perhaps the most extended of these passages is to be found in the famous speech of Ulysses in *Troilus and Cressida* concerning the value of degree, a passage almost certainly directly due to Marlowe. In his *Doctor Faustus*, Marlowe represents Mephistophilis as answering questions put by Faustus concerning the heavens. Faustus says:

> Come, Mephistophilis, let us dispute again
> And argue of divine Astrology.
> Tell me, are there many heavens above the moon?
> Are all celestial bodies but one globe,
> As is the substance of this centric earth?

and Mephistophilis replies:

> As are the elements, such are the spheres.
> All jointly move upon one axle-tree.

Faustus further asks

> How many heavens or spheres are there?

and Mephistophilis answers,

> Nine; the seven planets, the firmament and the empyreal heaven.
>
> (*Doctor Faustus*, 644-678)

In this learned colloquy note Mephistophilis' reference to "this centric earth" and the "axle-tree" of the spheres. Now turn to Ulysses' speech (*Troilus and Cressida*, I, *3*, 70-137), and observe that he mentions a bond "strong as the axle-tree on which heaven rides", and a moment later says:

> The heavens themselves, the planets, and this centre
> Observe degree, priority and place,
> Insisture, course, proportion, season, form,
> Office and custom, in all line of order;
> And therefore is the glorious planet Sol
> In noble eminence enthroned and spher'd
> Amidst the other. (I, *3*, 85-91)

The term "this centre" in line 85 is almost a repetition of Marlowe's "this centric earth".

Perhaps the feature of Ptolemy's system which appealed most to Shakespeare's imagination was that of the rolling spheres ("rowling spheares", Spenser *The Faerie Queene*, Bk. V, Introd. V). He speaks of "the music of the spheres" (*Pericles* V, *1*, 231); "the tuned spheres" (*A and C*, V, *2*, 84); "the great sphere in which the sun moves" (*A and C*, IV, *13*, 10); "the star moves not but in his sphere" (*Ham.* IV, *7*, 15); "and certain stars shot madly from their spheres" (*M.N.D.* II, *1*, 153). But he is especially captured by the idea that these spheres moving one upon the other give rise to a celestial music. Lorenzo, as he leads his Jessica to a bank bathed in the light of the moon, calls her attention to the heavens thus:

> Look how the floor of heaven
> Is thick inlaid with patines of bright gold,
> There's not the smallest orb which thou beholdest,
> But in his motion like an angel sings,
> Still quiring to the young-eyed cherubins,—
> Such harmony is in immortal souls;
> But while this muddy vesture of decay
> Doth grossly close it in, we cannot hear it.
>
> (*M. V.*, V, *1*, 58-65)

Let me quote a passage from Florio's Montaigne (*Of Custom* Bk. 1, 22). Speaking of "how custome quaileth and weakeneth our customary senses", Montaigne refers to "what Philosophers deeme of the celestiall musicke, which is that the bodies of its circles, being solid, smooth, and in their rowling motion touching and rubbing one against another, must of necessity produce a wonderful harmonie; by the changes and entercaprings of which the revolutions, motions, cadences, and carrols of the asters and planets, are caused and transported. But that universally the hearing senses of these low world's creatures, dizzied and lulled asleepe, as those of the Aegyptians are, by the continuation of that sound, how loud and great soever it be, cannot sensibly perceive or distinguish the same." (From *Cambridge Shakespeare, M. of V.*, p. 169). (The editor explains how Shakespeare read and used this paragraph.) This is a good example of the way in which Shakespeare utilized whatever came to his hand.

The motion attributed to some of the spheres is not difficult to understand. The sun and the moon at least appear to have a fairly simple pathway in the skies; so too have the fixed stars. Charles' Wain shows itself regularly to the ostler above the new chimney at 4 in the morning; (*I Henry IV*, II, *1*, 1), but the planet Mars at least was a horse of another colour.

"Mars his true moving", says the author of *I Henry VI* "to this day is not known" (I, *2*, 1-2) and it remained an unsolved puzzle till Kepler published in 1609 his great work *De Motibus Stellae Martis*, when many of the intricacies and irregularities of the geocentric system were smoothed out and fitted into their appointed places.

On the border line between astronomy and astrology is the general attitude to such phenomena as the comet and the eclipse. The interest in these features of the sky is on the one side purely scientific and on the other human. Shakespeare, one may almost dare to say, is more concerned with the belief that comets and eclipses influence human life than he is with any purely scientific attitude. The opening lines of *I Henry VI*, referring to the death of Henry V, run:

> Hung be the heavens with black, yield day to night!
> Comets, importing change of time and states,
> Brandish your crystal tresses in the sky,

> And with them scourge the bad revolting stars,
> That have consented unto Henry's death.
> (*I Henry VI*, I, *I*, 1-5)

A moment later another speaker asks,

> What, shall we curse the planets of mishap
> That plotted thus our glory's overthrow?

and a third speaker invokes the ghost of Henry V, calling on it to

> Combat with adverse planets in the heavens.

We cannot attribute these views to Shakespeare, since it is more than doubtful if he is the author of *I Henry VI*, but the quotations certainly point to the prevalence of the faith that comets and eclipses are a presage of trouble and misery for mankind. This view is supported by a speaker in *King John* (an undoubted play of Shakespeare), who accuses the people at large of cherishing just such superstitions. He says:

> No natural exhalation in the sky,
> No scope of nature, no distempered day,
> No common wind, no customèd event,
> But they will pluck away his natural cause
> And call them meteors, prodigies and signs
> Abortives, presages and tongues of heaven.
> (III, *4*, 153-9)

The dispute between the believer in signs and omens and the skeptic is set forth in detail in *King Lear*, where the Duke of Gloucester and his son Edmund are ranged on opposite sides. The Duke, deeply distressed by what he thinks to be a plot against his life by his other son Edgar, says to Edmund:

> These late eclipses in the sun and moon portend no good to us; though the wisdom of nature can reason it thus and thus, yet nature finds itself scourged by the sequent effects; love cools, friendship falls off, brothers divide; in cities mutinies; in countries discord; in palaces treason; and the bond cracked between son and father. This villain of mine comes under the prediction, there's son against father; the King falls from bias of nature, there's father against child. We have seen the best of our time: machinations, hollowness, treachery, and all ruinous disorders follow us disquietly to our graves.

The Duke leaves the stage, and his son, the master-villain of the play, soliloquizes:

> "This is the excellent foppery of the world, that, when we are sick in fortune, (often the surfeit of our own behaviour), we make guilty of our disasters, the sun, the moon and the stars: as if we were villains by necessity, fools by heavenly compulsion, knaves, thieves and treachers by spherical predominance; drunkards, liars and adulterers by an enforced obedience of planetary influence; and all that we are evil in, by a divine thrusting on; an admirable evasion of whore-master man, to lay his goatish disposition to the charge of a star." (*King Lear* I, *2*, 102-132)

His brother Edgar, against whose life he is plotting, is seen approaching, and he immediately puts on a mask. He pretends to be greatly distressed by the events which have recently taken place, viz., the disinheritance of Cordelia by the King, and the banishment of the faithful Kent. As his brother enters, he mutters aloud: "O these eclipses do portend these divisions", and hums dolefully "Fa, sol, la, mi". Edgar, catching the mood though not the words, asks: "How now, brother Edmund! What serious contemplation are you in?" and Edmund replies: "I am thinking, brother, of a prediction I read the other day, what should follow these eclipses." Edgar says, "Do you busy yourself with that?" and Edmund answer:

> I promise you, the effects he writes of, succeed unhappily; as of unnaturalness between the child and the parent; death, dearth, dissolutions of ancient amities; divisions in state, menaces and maledictions against king and nobles; needless diffidences, banishment of friends, dissipation of cohorts, nuptial breaches, and I know not what.

The innocent Edgar returns banteringly: "How long have you been a sectary astronomical?" One might, I suppose, imagine Shakespeare as holding the bottle between these two opposite points of view, were it not that we have unmistakable evidence elsewhere that he did not himself share in the popular belief. Cassius says to Brutus:

> Men at some time are masters of their fates:
> The fault, dear Brutus, is not in our stars
> But in ourselves that we are underlings.
> (*J. C.*, I, *2*, 138-141)

and Helen in *All's Well that Ends Well*, fortifies herself in a difficult and hazardous undertaking with a similar idea,

> Our remedies oft in ourselves do lie
> Which we ascribe to heaven; the fated sky
> Gives us free scope; only doth backward pull
> Our slow designs, when we ourselves are dull.
> (I, *1*, 223-6)

That, I think, settles the matter so far as Shakespeare is concerned. Hence, when Parolles, the braggart, says that he is warlike because born under Mars, and Autolycus says that he is thievish because littered under Mercury, we must take it as more or less what Thomas Hardy would call a manner of speaking on the part of Shakespeare and not really his own mind.

The Zodiac occupies quite a minor place in Shakespeare's plays. Taurus is mentioned by Sir Toby in *Twelfth Night*, and Poins in *I Henry IV* speaks of the "Trigon" in a conversation which must detain us for a moment. The face of Bardolph, richly coloured by countless potations, is a matter of ridicule at the hands of his patron Falstaff, who thus delivers himself to his retainer:

> Falstaff: Thou art the Knight of the Burning Lamp.
> Bardolph: Why, Sir John, my face does you no harm.
> Falstaff: No, I'll be sworn; I make as good use of it, as many a man doth of a death's head or a *memento mori*; I never see thy face, but I think upon hell-fire and Dives that lived in purple; for there he is in his robes, burning, burning. If thou wert in any way given to virtue, I would swear by thy face; my oath should be, "By this fire that's God's angel"; but thou art altogether given over; and wert indeed but for the light in thy face, the son of utter darkness. When thou rannest up Gad'shill in the night to catch my horse, if I did not think thou hadst been an *Ignis fatuus*, or a ball of wild-fire, there's no purchase in money. O, thou art a perpetual triumph, an everlasting bon-fire light! Thou hast saved me a thousand marks in links and torches, walking with thee in the night betwixt tavern and tavern: but the sack that thou hast drunk me, would have bought me lights as good cheap, at the dearest chandler's in Europe. I have maintained that salamander of yours will fire any time this two and thirty years; God reward me for it! (*I Henry IV*, III, *3*, 28-50)

It is the bearer of this same blazing beacon which Poins calls the "fiery Trigon". Trigon, says the Oxford Dictionary, is a set of three signs of the Zodiac. The Oxford Shakespeare Glossary describes it as the conjunction of three planets in a certain sign. E. B. Knobel calls it the combination of three signs of the Zodiac, Aries, Leo and

Sagittarius, all of the same hot and dry quality. At any rate it signifies an especially brilliant bonfire.

Shakespeare did not, I think, believe in the guidance of human life or any individual by the stars. But what did always fascinate him was the mystery of life. The goddess Fortune was never ignored by him, even if she was never really worshipped. For him Fortune was an open door into an enlarged and partly uncharted life. Hence the poet's predilection, too, for ghosts, witches and fairies. It was no mere stage trick that Hymen actually appears to the naked eye in *As You Like It*; that on the breast of Posthumus in Cymbeline was fastened a scrap of paper, whose origin no one could trace; that beyond the fringe and surface of our life there may be a tricksy spirit such as Ariel, or a monster such as Caliban; that any morning we may wake to find that strange and unmortal beings, as in *Midsummer Night's Dream*, have been in the house and been sweeping up the dust while we slept. We are never allowed to forget that the cloud-capp'd towers and gorgeous palaces will melt away, and even the globe itself dissolve, and that our little life is rounded with a sleep. Little wonder that Shakespeare in seeking to give the true dimensions of life should find himself at times fascinated by the glory and the mystery of the stars.

Edmonton, Alberta.

PLATE II

An oil painting by Mr. J. W. Sootheran of Stittsville, Ont., showing a bright fireball which appeared near Ottawa at 5.26 p.m. Oct. 22, 1938. This meteor was seen in the north-east from Ottawa and was pale green in colour, grading into a reddish shade in the tail.

PLATE III

An old woodcut, published in 1492, depicting the fall of the Ensisheim meteorite near the town of that name in Alsace. The meteorite fell shortly before noon, Nov. 7, 1492 (old style). It was a stone and weighed approximately 280 lbs. A piece weighing 120 lbs. is still hanging in the town hall of Ensisheim.

METEORS

By A. V. Madge

(With Plates II and III)

IT has been estimated that over one hundred million *meteors* strike the earth's atmosphere each twenty-four hours. These flashing meteors, which are the smallest of astronomical bodies, ranging in size from a grain of sand to boulders weighing many tons, constantly bombard our earth. Meteors are travelling at the terrific speed of from twenty to fifty miles a second. Were it not for our protecting atmosphere acting as a blanket, earth-dwellers would be living under chaotic conditions indeed; a rain of meteoric missiles would bombard us with deadly effect and the very existence of life on this planet would disappear. Well might the question be asked, "What are meteors and whence do they come?"

Many persons believe, when they observe a *meteor trail*, that they have seen a star falling toward earth. For years uninformed observers have held to this belief and, for many persons, a meteor trail is a "falling star". The fallacy of this belief is proven when it is realized that the background of stars remains the same as it was prior to the viewing of the meteor trail. (Other and more scientific methods of proof that meteor trails are not caused by falling stars need not be advanced at this time; let it be accepted that such proof has been made). What the observer does see is the result of a collision between the earth's atmosphere and a small body which may have been wandering at terrific speed through outer space for untold ages, its speed so great that earth's resisting atmosphere frictionally fuses it with heat intense enough to burn it into meteor dust, or, in the language of Peter M. Millman of the David Dunlap Observatory, "Meteors are small fragmentary particles of iron or stone, the debris of space, which, on entering the earth's atmosphere at high velocity, ignite and are in general completely vaporized."

Upon rare occasions (for the rarity of which if we are at all of a nervous disposition we should be truly thankful) the body of the meteor is so large that the vaporizing process is not entirely completed and it falls to earth and then, and then only, does it gain the distinction of being termed a *meteorite*. It has been estimated that approximately ninety per cent. of the original mass of a meteorite

is fused away during its flight through our atmosphere and that only ten per cent. of the original body reaches the earth in compact form. It might be interesting to point out that thousands of tons are being added to the earth's mass each year through the *meteoric dust* thus formed. However, this should not cause undue alarm for it would require many millions of years for a layer of meteoric dust to spread evenly an inch thick over the entire surface of the earth. Authorities are not in entire agreement on this rate of settlement and spread of meteoric dust so that no exact value can be given. No scientific distinction is drawn between meteors and meteorites, they are comprised of the same material and thus it is not difficult to arrive at the conclusion that the term meteorite is one of definition rather than of analysis. A meteorite is a meteor which has fallen to the earth—something like the distinction between a man who is "British" and a "Britisher" without inferring, of course, that all Britishers fall to earth. Again, no scientific distinction is drawn between a meteor which pursues its orderly way through our atmosphere and one that explodes "en passant" and thus secures for itself the honour of being termed a *bolide*, which is another name for a *fireball*. The explosion of a meteor in mid-air can be well understood when it is realized it may have sufficient velocity to pile up the atmosphere before it until it reaches an extremely high pressure, the effect being something like that obtained by heaving an electric light bulb against the pavement. Let us say that a meteor trail is observed; the object causing the trail is a meteor. It is seen to explode; it has now become a bolide. A piece falls to earth and is found; that piece is a meteorite. Something like calling a certain man named Smith, Mr. John Henry Smith, who may be still further classified as residing in a certain city, on a certain street, and at a certain number on that street. In much the same manner meteorites have been classified into three groups:

1. *Siderites* (metallic or iron meteorites)
2. *Aerolites* (stony meteorites)
3. *Siderolites* (intermediate or stony-iron meteorites).

According to Professor Fletcher, meteors contain some thirty elements identical, or almost identical, with those found on earth. His analysis shows the elements to be: aluminum, argon, calcium, carbon, chlorine, chromium, cobalt, copper, helium, hydrogen,

iridium, iron, magnesium, manganese, nickel, nitrogen, oxygen, palladium, phosphorus, platinum, potassium, radium, ruthenium, silicon, sodium, sulphur, titanium, germanium, arsenic, and vanadium. Gold, silver, lead, gallium, and tin were also found in minute quantities by Professor Fletcher. The carbon discovered in meteorites exists in two natural forms, as graphite and in the form of very minute diamonds. Naturally, all these elements do not occur at

Fig. 1.—The main mass of the Dresden Meteorite, the most recent Canadian fall. This stone fell at 8.50 p.m. E.S.T., July 11, 1939, at a point just south of Dresden, Ont. Weight is approximately 88 lbs.

the same time in every meteorite, but they do tell us something of the physical constitution of other heavenly bodies and lead us to the conclusion that matter contained in the earth, the other planets, the stars and their planets, and in all bodies throughout the universe, is identical to that known to man—though not necessarily in the same form. It is very fortunate for our physicists that meteorites, although their surfaces be fused into a white heat by their rapid passage through our atmosphere, retain in their interiors a temperature not far from that of outer space. For comparison, a ball of ice hung

on a string in a very hot room would melt very rapidly on the outside, but, as long as any ice remained, it would retain its original temperature in its interior. If the whole body of a meteorite became white hot, many of its elements would vaporize and be lost for analytical purposes.

Let us return to the three groups of meteorites as previously classified and discover where and why they differ: The *siderites* are

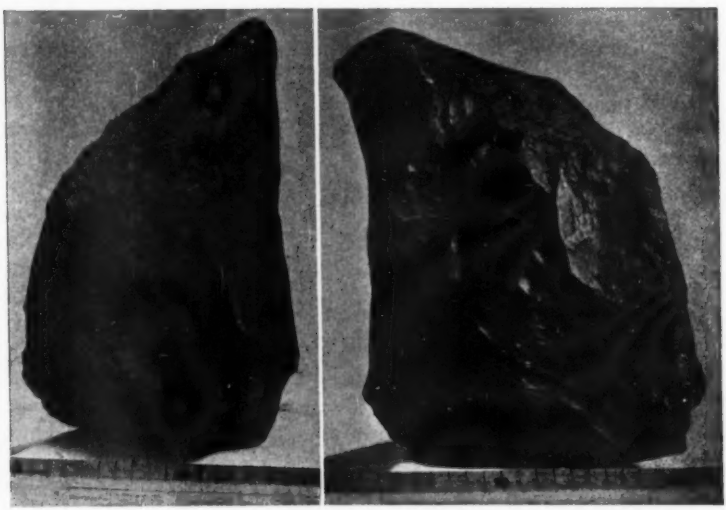

Fig. 2.—The two stones which fell within about one mile of each other near Shelburne, Ont., at 8 p.m. Aug. 13, 1904. The stones weighed 13 lbs. and 28 lbs. respectively. This fall, together with the Dresden fall, are the only two recognized Canadian meteorite falls in the twentieth century.

constituted mainly of iron alloyed with from 5 to 10 per cent. of nickel. They also contain traces of manganese, phosphorus, sulphur, platinum and chlorine. The chlorine causes them to be quickly destroyed by the oxygen of our atmosphere should they fall in a moist climate. This is the reason that iron, the most abundant of earth's metals, never occurs on the earth's surface as a metal as in siderites, but always in ores as an oxide. When siderites are machined smooth, polished and etched with a weak acid they show,

as distinguishing features, the beautiful crystalline *Widmanstätten figures* (lines or markings appearing on the smooth surface of certain meteoric irons when treated with acid; named after Aloys von Widmannstätten, a Vienna physicist, 1753-1849). Commercial iron does not show the same type of figure. It is interesting to learn that the iron-nickel alloy found in siderites pointed the way to the making of the tough nickel-steel alloy so essential to our present-day industry. The crystallized steel-grey iron-nickel phosphide found only in meteoric iron is named Schreibersite after Carl von Schreiber of

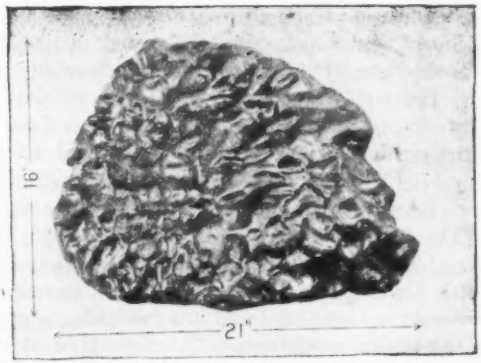

Fig. 3.—An iron meteorite, weight 386 lbs., which was found in 1869 near Iron Creek, Battle River, Saskatchewan.

Vienna. Oldhamite a transparent calcium sulphid occasionally found in meteorites, is named after Dr. Thomas Oldham, director of the Indian Geological Survey. These minerals are practically unknown in the earth's crust since, as mentioned earlier, they cannot exist long in the presence of oxygen and moisture. A meteorite containing these minerals very soon gains a distinct oxidized or "rusty" appearance. The *aerolites* contain about seventy-five per cent of magnesium and iron silicate which is known as olivine; this olive-green variety of chrysolite or arseniate of copper occurring in prismatic crystals and also in reniform (kidney-shaped), granular, and fibrous crusts, is found in certain earth rocks. All aerolites show surfaces of thin dark or grayish, more or less perfect, glass formed by fusion of the various constituents from heat gener-

ated during passage through our atmosphere, giving the meteorite a crusted, vitreous appearance. The *siderolites* from their very nature of being part siderite and part aerolite, generally contain the elements common to both siderites and aerolites. Siderolites generally are composed of a sponge-like network of nickel-iron alloy together with the other elements found in siderites, the interstices being filled with the stony material found in aerolites. No meteorite has ever been found that consisted of the sedimentary or metamorphic rocks common to earth such as limestone, marble, shale, sandstone, or slate, nor any unchallenged trace of animal or vegetable life, fossilification being entirely absent.

As previously mentioned, meteorites range in size from a grain of sand to boulders weighing many tons. Is there any proof of this statement? There is. In the Field Museum of Natural History the largest stony meteorite seen to fall in modern times is on view. This aerolite weighing some 800 pounds fell through our atmosphere on February 17, 1930, and blasted its way to a depth of nine feet in the ground on a farm at Paragould, Arkansas, from which it received the name "The Paragould Aerolite". Again, in 1905, Commander Peary during his search for the North Pole heard the Esquimaux tell of an object which could have been only a meteorite. It was finally discovered in Greenland and now, weighing some 36 tons, is the largest siderite on exhibition. The Greenland Meteorite is in the American Museum of Natural History. Two meteorites have been found in Mexico that weigh 30 and 15 tons respectively and another in Oregon that weighs about sixteen tons. The Grootfontein Meteorite, found in South West Africa several years ago and weighing at least 50 tons, presently carries the distinction of being the world's largest meteorite. Near Winslow, Arizona, there is a meteor crater some 4,000 feet in diameter and some 600 feet deep. It indicates that many years ago a gigantic meteorite crashed to the earth with force sufficient to bury itself one-quarter of a mile deep in the sedimentary rock. No one knows how large this meteor is or how much it will weigh when it is finally uncovered.

Where do meteors come from? In times when meteors were objects of worship by superstitious peoples, through the periods when meteors were objects of terror and "signs" from heaven were accepted for whatever fate they held in store, right thinking men have attempted to answer this question. Theories have been ad-

vanced that meteors are the fragments which were left over when our solar system was formed. Some authorities have stated that meteors are the congealed remains of gigantic solar eruptions. Other authorities believe that meteors have been attracted to our solar system by gravitational influence which harnessed them during the flight of our system through space. Still another theory is that meteors are the result of the eruption of lunar volcanoes many ages ago. Possibly there is some truth in all these hypotheses. It is now well known that in addition to the sun, the planets and their satellites, the solar system is also composed of comets and meteors and that, regardless of the origin of meteors, there are many well marked groups of meteors which travel in elliptical orbits around the sun and appear at definitely known periods. Such groups of meteors move along parallel paths and, when their path and that of the earth intersect, seem to radiate from a point in the sky known as the *radiant*, the shower being generally identified with and named after the constellation in which the radiant is located. In addition to these well marked groups of meteors, meteor trails may be seen almost every clear night and when such a meteor trail cannot be identified as coming from one of the plotted groups of meteors, it is termed a *sporadic meteor* or, when a small group of unidentified meteor trails are observed, it is termed a *sporadic shower*. It is quite possible that sporadic meteors might have their origin explained by any of the hypotheses just mentioned, but in the light of present day knowledge it does not seem that such would apply to the well-known meteor showers. It is now commonly accepted by most authorities that there is a very close relationship between comets and meteors and the theory that meteors result from the disintegration of comets is too well supported to be lightly brushed aside as being purely academic.

In the year 1826, Wilhelm von Biela, a German astronomer, made a special observation of a comet which now bears his name, Biela's Comet, and which had been noticed by other astronomers in 1772 and 1805. Its period was computed as being approximately six and three-quarter years. It was observed at each return until November 1845, when what was regarded as one of the most remarkable phenomena in the history of astronomy was observed to take place; on December 19, 1845, two American astronomers, Professor Herrick of Yale University and Francis Bailey of New Haven,

noticed that Biela's Comet had assumed a pear shape. Lieutenant Matthew Fontaine Maury of the United States Naval Observatory was the first astronomer to notice that, ten days later, it had divided into two separate but unequal parts. Professor Challis and J. Russel Hind, English astronomers, had also noticed this phenomenon. The two parts, separated by a distance of 165,000 miles, continued on the comet's regular orbit until lost to sight, observers having remarked that the appendage had disappeared during the process of separation. Astronomers watched carefully for the reappearance of the comet and, at their return in August 1852, it is recorded that the two parts had separated to a distance of some 1,500,000 miles and that, although the larger of the two divisions preceded the smaller by three weeks, both appeared equally bright. As comet bodies they are forever lost, for the next time the comet was due they failed to appear. However, on the night of November 27, 1872, as the earth crossed the orbit of Biela's comet, a dazzling display of meteors was observed. This shower was again observed in 1885 and in 1892 at the time when Biela's Comet would normally have been seen. Biela's Comet has not been observed since 1852 and it is now assumed that comets are only temporary bodies which sooner or later must break up into smaller comets or disintegrate into star dust or into showers of meteors which may be observed only when their orbit and that of earth intersect. It would seem only logical to accept the theory advanced by Professor Daniel Kirkwood of Indiana, who in 1861 said: "Meteors and meteoric rings are the debris of ancient and disintegrated comets whose matter has been distributed around their orbits."

Again, the theory is generally accepted because the great showers of meteors always seem to occur when the earth intersects and crosses the orbits of comets. Schiaparelli of Milan became interested in this field of new astronomical knowledge and in 1866 investigated the well known August shower of meteors, the Perseids. He noticed the marked resemblance between the parabolic elements of this meteor group with the elliptical elements of the Comet 1862-III and arrived at the conclusion that the general resemblance was too great to permit any doubt that the comet and meteors were moving in orbits of identical form. Therefore, he reasoned, the Perseids must be identified with Comet 1862-III. He found a similar resemblance between the Leonids and Tempel's Comet 1866-I. Weiss

RELATED METEOR SHOWERS AND COMETS

Shower	Approx. Radiant		Max. Date	Comet	Period of Comet
Lyrids.....	α 280°	δ+37°	Apr. 21	Thatcher (1861-I)	
ηAquarids.....	336	− 1	May 4	Halley	76·0
(Pons-Winnecke).	204	+53	June 28	Pons-Winnecke	6·2
Perseids.....	47	+57	Aug. 12	Swift (1862-III)	
Draconids.....	267	+54	Oct. 9	Giacobini	6·6
Leonids.....	152	+22	Nov. 16	Tempel (1866-I)	33·2
Andromedes.....	24	+44	Nov. 27	Biela	6·6

also found the Andromedes in agreement with Biela's comet, and the Lyrids with comet 1861-I. Since their time observers have found the orbits of the Aquarids and Halley's comet in agreement, and, in 1916, Olivier and Denning independently found a sixth connection between the meteors from a radiant in Ursa Major and the Pons-Winnecke comet. The most recent correlation of this kind was the appearance on Oct. 9, 1933, of the Draconid meteor shower which has been found to be moving in the path of Giacobini's comet. It appears that comets which are now pursuing their orderly way through our solar system throw off, and leave in their wake, streams of meteors which continue to follow the same orbit as that of their parent body. It is now generally supposed that the nucleus of a comet is composed of swarms of meteors, glowing with an incandescent heat resulting from collisions with one another, or luminous from some form of electrical action. This, however, has not yet been satisfactorily proven although few will deny that comets give birth to what we know as meteors.

It would seem thus far that a great deal of time and intelligence has been spent in the study of meteors and whence they come. There can be little doubt but that this study has given us a keen insight into the realm beyond our little world. We have learned that all things throughout the length and breadth of our known universe are in element akin. No one will deny that the study of comets and meteor paths has added materially to our mathematical knowledge, that this study has caused the human mind to think. If that were all, it is my opinion that the time were well spent. But can we say that this is all? What of the iron-nickel combination

of metals found in siderites that gave the suggestion to our laboratory technicians of processing the intensely tough nickel-steel alloy used in precision tools, automobiles, and armour plate? Is it not possible that scientists may find the clue to a rustless, long-lasting metal within some still unborn meteorite? Stainless steel that is not vulnerable to corrosion is yet to be discovered. The silvered steel "E" string of the violin, does it not point the way? Was this silver-steel combination not first found through the analysis of a meteorite? Will the meteorite lead us to the discovery of opalescent steel jewelry? Unshatterable steel glass? The transmutation of elements? The science of metallurgy is but in its infancy—physicists are still groping blindly for what may come. Who knows what the study of meteorites might bring about? Who knows?

Montreal, P.Q.

THE SIXTY-THIRD MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY, DECEMBER, 1939

By PETER M. MILLMAN

FROM December 27th to the 30th the Perkins Observatory at the cordial invitation of its director, Prof. N. T. Bobrovnikoff, played host to the American Astronomical Society. The observatory is situated on a slight rise a short distance outside of Delaware, Ohio,

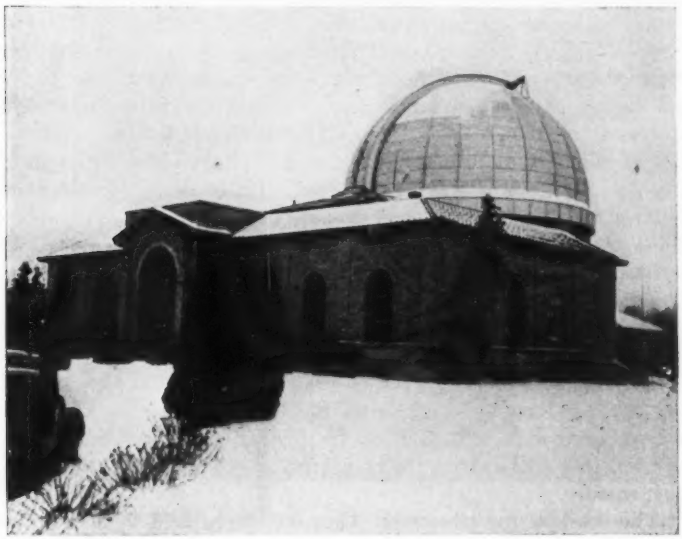

Fig. 1.—The Perkins Observatory.

and is operated jointly by Ohio Wesleyan University in Delaware, and Ohio State University in Columbus. This happy arrangement for cooperation between the two universities insures that the large sixty-nine-inch reflector is used to the fullest advantage. The erection of observatory and telescope was made possible through the bequest of the late Professor Hiram Mills Perkins (1833-1924), Professor of Mathematics and Astronomy at Ohio Wesleyan Uni-

of metals found in siderites that gave the suggestion to our laboratory technicians of processing the intensely tough nickel-steel alloy used in precision tools, automobiles, and armour plate? Is it not possible that scientists may find the clue to a rustless, long-lasting metal within some still unborn meteorite? Stainless steel that is not vulnerable to corrosion is yet to be discovered. The silvered steel "E" string of the violin, does it not point the way? Was this silver-steel combination not first found through the analysis of a meteorite? Will the meteorite lead us to the discovery of opalescent steel jewelry? Unshatterable steel glass? The transmutation of elements? The science of metallurgy is but in its infancy—physicists are still groping blindly for what may come. Who knows what the study of meteorites might bring about? Who knows?

Montreal, P.Q.

THE SIXTY-THIRD MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY, DECEMBER, 1939

By Peter M. Millman

FROM December 27th to the 30th the Perkins Observatory at the cordial invitation of its director, Prof. N. T. Bobrovnikoff, played host to the American Astronomical Society. The observatory is situated on a slight rise a short distance outside of Delaware, Ohio,

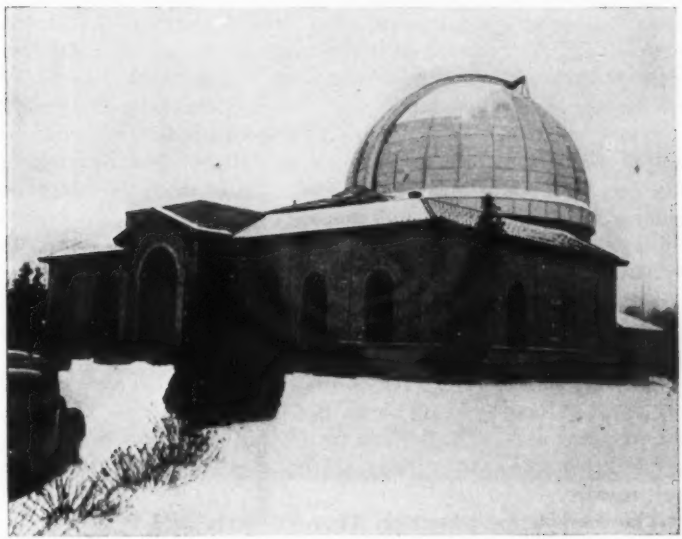

Fig. 1.—The Perkins Observatory.

and is operated jointly by Ohio Wesleyan University in Delaware, and Ohio State University in Columbus. This happy arrangement for cooperation between the two universities insures that the large sixty-nine-inch reflector is used to the fullest advantage. The erection of observatory and telescope was made possible through the bequest of the late Professor Hiram Mills Perkins (1833-1924), Professor of Mathematics and Astronomy at Ohio Wesleyan Uni-

versity. The large reflector is at the present time the fifth in order of size of telescopes in operation. This is not the first time the American Astronomical Society has enjoyed the hospitality of Delaware and we who attended the recent meetings certainly hope that it will not be the last.

There was a council meeting Wednesday night, December 27th, but the sessions for papers did not commence until Thursday morning. Members found southern Ohio blanketed under a fairly heavy snowfall which became a glassy surface on the highways and considerably embarassed Ohio motorists. The natives conscientiously assured all visitors that this was most unusual weather. A distressing telegram was received on Thursday from the Leander McCormick Observatory party from which we learned that, like many another expedition attempting to traverse the snow-bound icy wastes of our planet, they had been turned back, finding it impossible to push through. Professor S. A. Mitchell had fortunately taken another route and was present, clearly demonstrating the practical value of the years he has spent chasing eclipses around the globe.

Austin Hall, one of the dormitories of Ohio Wesleyan University, served as a very comfortable headquarters for the duration of the meetings. Visitors were supplied with accommodation in this building at a very reasonable rate, meals were served here, and the lounge was made available for informal discussions, the making of new acquaintances and the renewal of old ones. Professor and Mrs. Bobrovnikoff were indefatigable in their efforts to anticipate the wants of their guests with the result that everyone was looked after most royally.

The sessions for papers on Thursday were held in a room of Austin Hall. Some business of rather ominous interest to every member was transacted at the afternoon session. The annual fees were raised from two dollars to three dollars, a step necessitated by the fast diminishing balance of cash in the treasury. It is my painful duty to report that facetious remarks were passed concerning possible methods of financing certain trips recently indulged in by our treasurer, Prof. Frank C. Jordan, but these he faced with the calm assurance of an honest man who has had his accounts audited. The Society picture, scheduled for noon, was taken on the steps of Sanborn Hall after a slight delay, during which it was feared that

the photographer might also have lost his way in the snow. Thursday afternoon we received cordial addresses of welcome from Dr. Burgstahler, President of Ohio Wesleyan University, and Dr. Smith, Dean of the Graduate School, Ohio State University. Dr. and Mrs. Burgstahler received at a reception for the Society, held at the close of the afternoon session for papers.

Fig. 2.—The Buffet Luncheon in the library of the Perkins Observatory, Dec. 29, 1939.

Friday morning was devoted to a visit to the Perkins Observatory. A demonstration of the telescope was followed by the presentation of a number of papers by members of the staff of the observatory. Prof. Bobrovnikoff outlined the history of the observatory, tracing the evolution of the present satisfactory solution of past difficulties whereby Perkins Observatory serves as the astronomical research institution of two neighbouring universities. Dr. C. E. Hesthal described the most significant recent addition to the instrumental equipment of the observatory, the new two-prism

spectrograph which is mounted on the 69-inch telescope. This spectrograph was designed by Dr. Hesthal to operate with maximum efficiency under the conditions of average to poor seeing commonly met with in southern Ohio. The instrument features prisms which are particularly transparent to ultra violet light, a long collimator

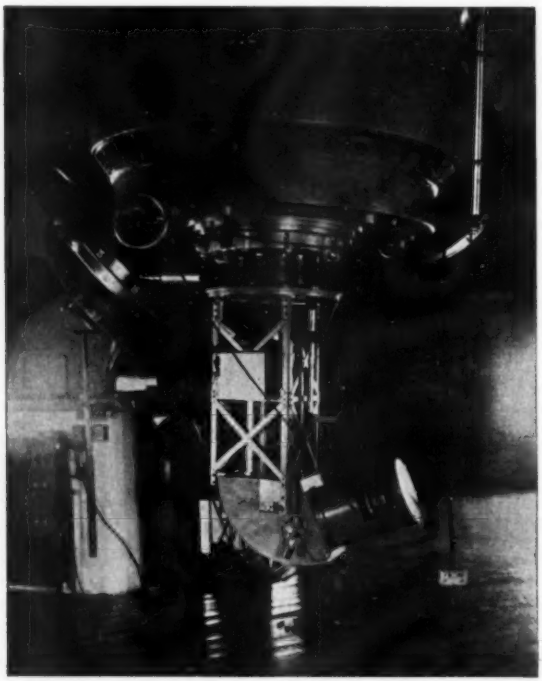

Fig. 3.—The new two-prism spectograph designed by Dr. C. E. Hesthal. This is mounted on the 69-inch reflector of the Perkins Observatory.

(130 cm.) to permit the use of a wide slit, four interchangeable cameras with aperture ratios from f/4.8 to f/1.75, and a very efficient type of temperature control employing a Wheatstone-bridge thermostat. Spectra already secured show beautiful definition from λ3600 to λ6600. A convenient accessory in operating the

69-inch telescope is a rising floor operated by hydraulic lift. This eliminates the necessity of long ladders. The activities of the morning were brought to a close by a most delectable buffet luncheon provided by the observatory. I feel impelled to digress here for a moment on the excellence of Ohio cooking. In my opinion we fared more than well throughout the whole course of our visit and mention of the Delaware meeting of 1939 will always recall memories of all-round excellence in culinary art. I trust that there are few astronomers who are so engrossed in their work that they have no leisure to appreciate a well-cooked meal.

The Friday afternoon session was held in Columbus, in the Chemistry Building of the Ohio State University. This was a combined session with Section D of the American Association for the Advancement of Science which was holding its Annual Winter Meeting in Columbus at this time. Dr. Philip Fox, Vice-President of the A.A.S., who had taken the chair up to this time, now resigned it in favour of Prof. E. I. Yowell, Chairman of Section D of the A.A.A.S. The meeting was opened with the address of the retiring chairman of Section D, Mr. R. Meldrum Stewart, Dominion Astronomer and Director of the Dominion Observatory in Ottawa. He gave an account of some important experiments which have been carried out at Ottawa concerning the regulation of free-pendulum clocks. It is a well-known fact that the exact period of a pendulum varies with the amplitude. Mr. Stewart computed that, if the gravity impulse is given to the pendulum not at the centre of swing, but at some mathematically determined point off centre, then the rate will remain practically constant even though the amplitude should vary by a considerable amount. Rate curves showing the performance of various clocks under different conditions supported the theoretical conclusions.

The Society dinner was held Friday evening in Austin Hall. Each one attending this function received an attractive, well-illustrated little booklet, summarizing the history of the observatory from the date when Prof. Perkins made his first gift to the university up to the present. It includes some excellent examples of photographs made with the 69-inch and was just off the press that very afternoon. The dinner wound up with some significant comments by Prof. Joel Stebbins and others. These remarks were both serious

and otherwise, mostly otherwise. After the dinner we had the pleasure of viewing some of the latest motion pictures of solar prominences taken at the McMath-Hulbert Observatory, University of Michigan. A recent improvement has been to photograph the prominences and the adjacent portions of the solar disk simultaneously by means of inserting a filter over the disk to equalize the exposures. In this way the motions of gases over the surface can be viewed together with the associated prominences. The predominance of downward motion in the latter is very striking. It is just as if the gas was shot up from the solar surface while invisible and then became visible as it started to cascade down on to the photosphere again. Occasionally one notes an eruptive prominence blown off from the surface with very high velocity. After the showing of these films, those of us who could remained to see some excellent kodachromes of Mars and Jupiter taken last summer at the Steward Observatory by Mr. E. Martz.

Fifty-one papers were listed on the printed programme and several more were added later so that there was no lack of material for the technical sessions. It is impossible to give an adequate review of these here and only a few points will be mentioned. D. B. McLaughlin gave three general rules which seemed to govern the behaviour of a nova spectrum after maximum. He pointed out that the so-called slow novae are not an exceptional class and that the spectra of supernovae do not seem to follow the rules laid down for the typical novae. P. Swings and Otto Struve reported that iron ionized as many as nine times had been identified in stellar spectra. A number of other papers dealt with interesting features in the spectra of various peculiar stars. P. van de Kamp made as trong plea for more accurate parallax determinations of certain visual binaries where the mass ratio of the two stars had been fairly accurately determined. Only in this way can we obtain the true masses of these stars.

N. T. Bobrovinkoff reported on one phase of a very extensive investigation of comets which he has undertaken. Since under a low power a comet appears brighter than it does under higher power the magnitude estimates for all comets were first reduced to those determined with telescopes averaging about three inches. The following empirically determined reduction factors were used:

Observations with naked eye	+0.61	magnitudes
" " binoculars	+0.47	"
" " 3-inch telescopes	0.00	"
" " telescopes to 10 inches	−1.24	"

Formulae for expressing the brightness of the comet in terms of its distance from the sun and other factors were then developed. These introduced terms which made the brightness depend not only on the conditions which existed at the moment but on those which had obtained some time previously. In this way it was found possible to compute a curve which followed the actual observations well within the order of their accuracy. It thus appears that the brightness of comets is not so erratic or unpredictable as might at first be supposed.

The trend towards instruments which perform an ever greater percentage of the work was indicated in the description by S. W. McCuskey and R. M. Scott of a photoelectric machine which automatically counts all stars on a plate between certain limits of brightness; and also in the report of Robley C. Williams and W. A. Hiltner of a new microphotometer which automatically records the true intensities on a plate. E. J. Moulton suggested some modifications of the theory which assumes the formation of the planetary system to be the result of intense tidal action incident on the approach of two stars. He pointed out that when the two stars are at their closest the direction of the line between them will vary with great rapidity for a short time, in marked contrast to the earlier stages of the approach. If full account is taken of this time factor much of the difficulty concerning the distribution of angular momentum is removed.

The report on the 1939 observations of Mars by E. C. Slipher of the Lowell Observatory was one of great general interest and scientific importance. Dr. Slipher carried out his work with the 27-inch refractor of the Lamont-Hussey Observatory near Bloemfontein, South Africa. At this location Mars crossed the meridian very near the zenith, giving optimum conditions for the observation of the planet. The average exposure was one-quarter of a second with specially sensitized plates prepared by the Eastman Kodak Co. The detail secured on these photographs was really remarkable. Dr. Slipher stated that he had photographed detail 0.″18 wide and some possibly as narrow as 0.″15. At the distance of Mars in 1939 this

would correspond to a width of between 26 and 31 miles on the surface of the planet. Dr. Slipher stressed the reality of the "canals," rather than their interpretation, and stated that, whatever their exact form and nature, they were certainly present since during the last 35 years the Lowell Observatory has photographed at some time practically everything on the surface of the planet that has been recorded visually. The slides with which the paper was illustrated clearly showed many of the canals. One in particular showed the double *Gehon* running north from the *Sabaeus Sinus*, and the apparent parallelism of the narrow lines in the photographic image was quite striking. Drawings of the face of the planet by Barnard, Dawes, Trumpler, and others were shown. These were all centered on the same meridian and reproduced the same set of canals. With this evidence on the screen Dr. Slipher requested his audience not to repeat the historically inaccurate statement, so often found in text books, that Barnard had never been able to see the canals of Mars. Other points stressed were the ever-varying nature of the surface, illustrated by the photography in 1939 of an entirely new oasis just off the north-west edge of the *Syrtis Major*, the marked north polar cloud cap, which varied greatly in strength and position from day to day, and the permanence of the rifts and irregularities in the south polar snow cap, which appear at the same places year after year. This work of the Lowell Observatory should lend fresh impetus to the careful scientific observations of Mars in 1941, when we will have an opposition equally favourable with that of 1939.

The dinner on Friday evening completed the official programme of the American Astronomical Society but a number of us were interested in a joint session of the Society for Research on Meteorites and Section D of the A.A.A.S. which was held in Columbus Saturday morning. Professor Frederick C. Leonard, Past-President of the S.R.M., took the chair and four papers on meteors, meteorites, and associated subjects were presented. Dr. Fletcher Watson reported on experiments with grey chondrites which have recently been carried out at Harvard. It was found that on heating these in a furnace they become black chondrites at a fairly sharp transition point between 800° and 1000° C. Since some five per cent of stony meteorites are black chondrites the question is raised as to how they reached this condition. Chance approaches to stars

are quite inadequate to account for the observed percentage of black chondrites.

Professor Lincoln La Paz discussed the distribution of 57 ray craters on the moon and showed that according to correct probability theory utilizing Poisson's equation the distribution of these craters is quite at random, with respect to the sector of the lunar surface in which they are located. This result is a good support for the meteoric theory of origin for these craters, and corrects the results of previous investigators who did not take full account of the natural uncertainty of small numbers.

Professor La Paz, who is on the staff of Ohio State University, also organized a very interesting display of meteorites under the auspices of the Society for Research on Meteorites. This was in the Civic Auditorium in Columbus where nearly a hundred booths demonstrated to the public some of the interesting results of science. Included in the meteorite exhibit was a large collection of irons, recently recovered by Professor La Paz from below the surface of the ground near the Odessa meteor crater in Texas. These were found by means of a meteorite detector which, through an amplified electric circuit, gives out a strong note any time a piece of iron is placed in front of it. This instrument was designed by Professor La Paz and was demonstrated by a small working model in the exhibit. The development of this instrument and the collection of all these new irons marks a distinct service to science and is the result of a co-operative effort of the La Paz family since I understand that Mrs. La Paz and her two daughters go along on these meteorite expeditions and that the two girls have become as expert at locating meteorites as their father. I am certain that we shall hear more of the La Paz meteorite collection in the future.

Right across from the meteorites were a number of booths devoted to Astronomy in Ohio, Astronomy in the Eastern States, and Astronomy on the Pacific Coast. These included the transparent model of the 200-inch, a model of Jupiter's satellite system, a beautifully constructed three-dimensional model of the Russell diagram, and many other things of equally great interest. I understand that most of the credit for this display should go to Dr. Ernest Cherrington of the Perkins Observatory as he organized the exhibit. Unfortunately we did not have time to see more of booths as the programme stated that the exhibits would close at 1.00 p.m. and

close they did, in fact I never saw anything close quicker. At about 12.58 p.m. large groups of burly moving men appeared clustering in strategic corners of the hall, at 1.00 p.m. a gong sounded and a stentorian voice announced over a public address system that the exhibition was at an end, by 1.05 the partitions between the booths were already being dismantled and by 1.12 p.m. E.S.T. the show cases and the tables were on their way to the vans while Professor La Paz extracted the last of his meteorites from its case which was by now half way to the entrance. So ended the one hundred and fifth meeting of the A.A.A.S. As the various groups of visitors returned home I am sure that there was a general feeling of appreciation for the efficient way in which the local scientists had co-operated to make the meetings of such definite interest and value.

David Dunlap Observatory,
Richmond Hill, Ontario.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Making a Virtue of Necessity

The "black-out" has become a familiar feature of the present war, and it is found to be an uncomfortable nuisance as well as the cause of some accidents. But, as in most things which we are called upon to endure, there is a side to it which is not so dark and which offers some slight compensation. Mr. David J. Howell, one of the earliest members of the Royal Astronomical Society of Canada, now living at Berrynarbor in North Devon, England, writes:

> The "black-out" has improved the outlook of the observatories. I think the Astronomer Royal has stated that it has made a great improvement in conditions for observing. Then some people have found that there are stars in the sky! I have been doing just a little to tell these ignorant people that the stars have names and to give some other information about them; but I have no desire to stand around after dark on these cold nights and so do not do much instruction. It is very awkward anyway as I can't hear a word, and folks shy at writing to ask about these and other things. So we are left very much to ourselves. However our dogs cannot talk and we can understand them pretty well. It is really marvellous how much they understand of what we say and of what goes on.

"When the Earth Split"

A Query bearing this title was presented in our issue for October, 1939, and a discussion of it appeared in the December issue. For some further references to the subject the present writer wishes to thank Mr. Daniel P. Gillmor, K.C., of Montreal, who gives the names of several writers, with a brief summary of the views of two of them. He writes:

> Further to the inquiry of F. T. S., in the October number of The Journal, I would refer you to "The Earth and Man," by Arnold Guyot, translated by C. C. Felton, revised edition published by Charles Scribner's Sons, 1895.
>
> On page seventeen, a discussion bordering on our inquiry commences. Reference is made to Bacon, Reinhold, Forster, Pallas, Humboldt, Steffens and Carl Ritter.
>
> Forster and Pallas are of the opinion that there was a great cataclysm coming from the southwest, the waters scooped out the deep gulf open towards the southwest, swept off all the movable earth from the southern side, and left nothing

standing but those rocky points that formed only the skeleton. The islands on the east would be only the accumulated ruins of this great catastrophe, or the pieces of the continent protected from total destruction by the jutting point which received the first shock.

This is only a reference, and not my opinion.

Stourbridge Fair, Newton's Prism

In this Journal for 1935 (p. 418) among some notes of travel it was stated that in Worcestershire, England, was a town called Stourbridge wherein was observed a sign, "Flint Glass Made Here." Now early in 1666 Newton obtained at Stourbridge Fair the glass prism with which he performed his famous experiment of decomposing white light, and the question arose, Was the fair at this town?

In Pepys's "Diary" six references to the Stourbridge Fair are to be found. In the entry for 1661 September 19, he describes a visit he made to Cambridge on business affairs and says:

> So after I had talked and advised with my coz Claxton, and then with my uncle at his bedside, we all horsed away to Cambridge, where my father and I . . . went to Mr. Sedgewicke, the steward of Gravely, and there talked with him, but could get little hopes from anything that he would tell us; but at last I did give him a fee, and then he was free to tell me what I asked, which was something though not much content. From thence to our horses, and with my wife went and rode through Sturbridge fair, but the fair was almost done. So we did not 'light there at all, but went back to Cambridge. . . .

The other references to the fair are in the entries for 1664 August 22; and 1668 July 1, September 8, 15 and 17. In Wheatley's edition (1893), vol. IV, p. 224 is a note to the 1664 entry as follows:

> Sturbridge Fair, which is still held, is of great antiquity. The first trace of it is to be found in a charter granted about 1211 by King John to the Lepers of the Hospital of St. Mary Magdalen at Sturbridge by Cambridge. The fair was to be held in the close of the hospital on the vigil of the feast of the Holy Cross. The name is derived from the little river of Stere or Sture, flowing into the Cam near Cambridge.

C. A. C.

MEETINGS OF THE SOCIETY

AT VICTORIA

October 11, 1939.—A regular meeting of the Victoria Centre of the Royal Astronomical Society of Canada was held in the Y.W.C.A. Parlours. The president, Mr. R. Peters, was in the chair. Three new members, Mr. E. Buckle, Mr. E. V. Morris, and Mr. Alan B. Ford were welcomed to the Society.

Mr. K. O. Wright discussed several current phenomena of the skies. The almost total eclipse of the moon of October 27th was particularly noted, also the positions and relative brightness of the planets at the present time.

The speaker of the evening was Dr. R. M. Petrie, who had chosen as his topic, The Atmospheres of the Planets. Dr. Petrie explained that the whole knowledge pertaining to atmospheres of the planets has been revolutionized in recent years. These advances have come about largely because of three influences: (1) an increase in knowledge of the physical spectra, (2) improvement in the photographic plate, and (3) the application of large telescopes to the photographic plates. The speaker enumerated and enlarged upon the following main lines of evidence which definitely prove or disprove the retention of an atmosphere by any given planet: (1) telescopic appearance, (2) reflecting power, (3) twilight effects, (4) evidence derived from the use of the telescope, and (5) knowledge of gravitational effects of the surface of the planet as compared with the temperature. Each planet was discussed in turn and results of observations may be summed up as follows: (a) small planets do not have atmospheres, (b) medium-sized planets have atmospheres containing oxygen and oxygen compounds, (c) giant planets have atmospheres containing hydrogen and hydrogen compounds. All important points throughout the lecture were illustrated with many well chosen slides.

Dr. J. A. Pearce moved a vote of thanks to Dr. Petrie for his splendid address, which the audience approved in the usual manner.

Professor W. H. White of London spoke briefly to the Society.

Attention was called to the new bookcase and to the fact that Miss Langworthy is acting librarian in the absence of Miss Hailstone.

November 1, 1939.—A regular meeting of the Royal Astronomical Society of Canada, Victoria Centre, was held in the Y.W.C.A. Parlours. Owing to illness of the president, the Vice-President, Dr. R. M. Petrie, was in the chair. Miss Hailstone, the librarian, was welcomed back. It was pointed out that the weekly radio addresses were continuing over CFCT every Tuesday at 7.30 p.m. Dr. R. M. Petrie outlined the main features of current phenomena of the sky.

The speaker of the evening was Miss Phoebe Riddle, who had chosen as

her topic, Astronomical Fallacies. These fallacies or misconceptions were divided into four main groups: (1) those connected with astronomers and observing, (2) with the solar system, (3) with stars and constellations and (4) with theories of the universe as a whole. The second group was discussed in greatest detail; our satellite received the most attention since this body seemed to be the source of the great majority of popular but erroneous notions connected with astronomy. In connection with the third group the speaker pointed out that the number of stars visible to the unaided eye is vastly smaller than is commonly suspected. Common beliefs connected with rising and setting of stars, with Polaris, and with origins of the constellations were mentioned. In conclusion it was pointed out that the truths of today may be the fallacies of tomorrow, that ultimate truth in science and astronomy is still awaiting discovery.

A vote of thanks was moved by Dr. C. S. Beals and seconded by Mr. G. Shaw.

P. Riddle, *Recording Secretary.*

AT EDMONTON

October 19.—Mr. H. B. Doughty spoke on "Sundials". He described primitive Egyptian, Chaldaean and Greek forms, and the development of more and more accurate types, culminating in dials so good that they were used to check watches. He explained the difference between sundial time and local time, and how the correction to standard time would be applied.

By means of some worked examples, he illustrated the principles involved in dialling, and concluded with some examples of the mottoes which are so often found on old sundials.

At this meeting an old portable brass sundial of the universal ring type, made in London, was exhibited. It had been turned up by the plough in a field in Southern Alberta, and was in excellent preservation.

November 16.—Dr. E. H. Gowan gave an account of "A South-west Summer", describing experiences of astronomical interest met with during the summer of 1939 spent in California. The talk was illustrated by coloured and black-and-white slides made by himself. Apart from some glimpses of Yellowstone and Zion Parks, and of San Diego and San Francisco, the talk dealt mainly with the Griffith Planetarium in Los Angeles and the many interesting exhibits in the museum attached, the dome and mounting for the new 200-inch telescope at Mount Palomar, the grinding and testing of the 200-inch mirror in Pasadena, and the Mount Wilson Observatory.

E. S. Keeping.

The Royal Astronomical Society of Canada

OFFICERS FOR 1939

Honorary President—The Hon. Leonard J. Simpson, M.D., Minister of Education for the Province of Ontario.
President—Wm. Findlay, M.A., Ph.D., Hamilton, Ont.
First Vice-President—J. A. Pearce, M.A., Ph.D., Victoria, B.C.
Second Vice-President—F. S. Hogg, M.A., Ph.D., Toronto.
General Secretary—E. J. A. Kennedy, 198 College St., Toronto.
General Treasurer—J. H. Horning, M.A., Toronto.
Recorder—R. H. Combs, Toronto.
Curator—R. S. Duncan, Toronto.
Librarian—P. M. Millman, M.A., Ph.D., Toronto.
Council—D. S. Ainslie, M.A., Ph.D., Toronto; D. W. Best, D.D., Toronto; S. C. Brown, Toronto; H. Boyd Brydon, Victoria; Miss A. V. Douglas, Ph.D., Montreal; E. A. Hodgson, M.A., Ph.D., Ottawa; Major E. H. Arundson, London, Ont.; J. A. Marsh, M.P., Hamilton, Ont.; A Thomson, M.A., Toronto; L. A. H. Warren, M.A., Ph.D.; and Past Presidents—Sir Frederick Stupart; C. A. Chant, M.A., Ph.D., LL.D.; A. T. DeLury, M.A.; J. S. Plaskett, D.Sc., F.R.S.; A. F. Miller; J. R. Collins; W. E. W. Jackson, M.A.; R. M. Stewart, M.A.; A. F. Hunter, M.A.; W. E. Harper, M.A., D.Sc.; H. R. Kingston, M.A., Ph.D.; R. K. Young, Ph.D.; L. Gilchrist, M.A., Ph.D.; R. E. DeLury, M.A., Ph.D., and the presiding officer of each Centre.

TORONTO CENTRE

Honorary Chairman—Dr. C. A. Chant — *Chairman*—S. C. Brown
Vice-Chairman—Dr. D. W. Best — *Secretary*—F. L. Harvey, 80 Gates Ave.
Recorder—Miss R. J. Northcott, M.A. *Treasurer*—T. H. Mason *Curator*—R. S. Duncan
Council—Dr. D. S. Ainslie; Dr. L. Gilchrist; Dr. J. F. Heard; Dr. F. S. Hogg; J. H. Horning; Dr. P. M. Millman; Rev. C. H. Shortt; Tracy D. Waring; Dr. R. K. Young; and Past Chairmen—A. F. Miller; A. F. Hunter; J. R. Collins; A. R. Hassard; and E. J. A. Kennedy.

OTTAWA CENTRE

Honorary President—John McLeish, B.A. — *President*—Miss M. S. Burland, B.A.
First Vice-President—F. W. Matley — *Second Vice-President*—Dr. T. L. Tanton
Secretary—Malcolm M. Thomson, Dominion Observatory *Treasurer*—A. C. Steedman
Council—Hoyes Lloyd; R. G. Madill; W. W. Nichol; C. B. Reilly, K.C.; D. B. Nugent; and Past President A. H. Miller.

HAMILTON CENTRE

Honorary President—Mrs. D. B. Marsh — *President*—Geo. E. Campbell
First Vice-President—T. H. Wingham — *Second Vice-President*—W. T. Goddard
Third Vice-President—W. S. Mallory
Secretary-Treasurer—H. Fox, Jr., 257 Balmoral Avenue N.
Curator—T. H. Wingham
Council—Dr. Wm. Findlay; Dr. A. E. Johns; J. A. Marsh, M.P.; Rev. E. F. Maunsell; N. H. Broadhead; E. G. Freeman; J. S. Taylor; E. E. Bossence; F. H. Butcher.

WINNIPEG CENTRE

Honorary President—Mgr. T. W. Morton — *President*—R. D. Colquette
First Vice-President—L. J. Crocker — *Second Vice-President*—G. P. Morse
Treasurer—R. S. Evans
Secretary—Miss Margaret E. Watterson, 909 Boyd Building
Council—Miss O. A. Armstrong; W. R. Junkin; L. W. Koser; C. A. E. Hensley; L. McAllister; Mrs. J. Norris; Dr. L. A. H. Warren.

VICTORIA CENTRE

Honorary President—C. S. Beals, Ph.D. — *President*—Robert Peters
First Vice-President—R. M. Petrie, Ph.D. — *Second Vice-President*—Capt. Wm. Everall
Secretary-Treasurer—Andrew McKellar, Ph.D., Dominion Astrophysical Observatory
Recorder—Miss P. Riddle, B.A. — *Librarian*—Miss C. Hailstone
Council—L. Hopkins; R. Hopkins; Miss Langworthy; O. M. Prentice; J. Smith; W. A. Thorne; K. O. Wright, B.A.

MONTREAL CENTRE

Honorary President—Mgr. C. P. Choquette — *President*—E. Russell Paterson
First Vice-President—F. de Kinder
Secretary-Treasurer—A. Vibert Douglas, Ph.D., McGill University
Librarian—F. de Kinder
Council—A. Norman Shaw; W. E. Lyman; G. Harper Hall; G. R. Lighthall; O. A. Ferrier; H. F. Hall; J. Addison Reid; C. C. Birchard.

LONDON CENTRE

Honorary President—Dr. H. R. Kingston — *President*—Rev. W. G. Colgrove
Vice-President—T. C. Benson *Secretary-Treasurer*—Dr. G. R. Magee, 427 William St.
Council—O. Kilburn; D. M. Hennigar; Miss S. Livingstone; W. L. Scandrett; J. Middlebrook; and Past President J. C. Higgens.

VANCOUVER CENTRE

Honorary President—Dean Daniel Buchanan, M.A., Ph.D., LL.D., F.R.S.C.
President—C. A. McDonald — *First Vice-President*—C. E. Bastin
Second Vice-President—D. L. Shaw, B.Sc., M.S.
Secretary—A. M. Crooker, M.A., Ph.D., University of British Columbia
Treasurer—Harold D. Smith, M.A., Ph.D.
Past Presidents—Mrs. Laura Anderson; J. C. Jorgenson; H. P. Newton; Mrs. C. A. Rogers; F. R. Stewart; J. Teasdale; E. C. Thrupp; William Ure, M.A., Ph.D.

EDMONTON CENTRE

Honorary President—Dr. J. W. Campbell — *President*—W. O. Coulman
Vice-President—John Blue — *Treasurer*—E. N. Higinbotham
Secretary—Dr. E. S. Keeping, University of Alberta
Council—Mrs. J. A. Clarke; Dr. E. H. Gowan; Dr. J. R. Tuck; H. P. Doughty; Mrs. J. G. Taylor; Miss A. Smith; C. G. Wates.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
1890-1940

This year marks the completion of the first fifty years of the corporate existence of our Society. The Society was incorporated in 1890 under the name of The Astronomical and Physical Society of Toronto, and assumed its present name in 1903.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal, P.Q.; Ottawa, Toronto, Hamilton and London, Ont.; Winnipeg, Man.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as about 700 members of these Canadian Centres, there are over 200 members not attached to any Centre, mostly resident in other nations, while some 300 additional institutions or persons are on the regular mailing list for our publications.

The Society publishes a monthly JOURNAL containing about 500 pages and a yearly OBSERVER'S HANDBOOK of 80 pages. Single copies of the JOURNAL or HANDBOOK are 25 cents, postpaid. In quantities of 10 or more copies, the price is 20 cents a copy.

Membership is open to anyone interested in astronomy. Annual dues, $2.00; life membership, $25.00. Publications are sent free to all members or may be subscribed for separately. Applications for membership or publications may be made to the General Secretary, 198 College St., Toronto.

The year 1940 also marks the hundredth anniversary of the founding in Toronto of the first Observatory (magnetic) in Canada. This was one of the first magnetic observatories in the world and became the nucleus of observatory development in Canada.

To mark the semi-centennial of the founding of our Society and the centenary of the founding of the first observatory, our Society plans to hold a special meeting in Toronto in the late summer. It is also planned to publish as a feature of the JOURNAL, articles and early documents dealing with the histories of the observatory and of the society.

The Society has for Sale:

Reprinted from the JOURNAL of the Royal Astronomical Society, 1936-1939.

The Physical State of the Upper Atmosphere, by B. Haurwitz, 96 pages; Price 50 cents postpaid.

The Small Observatory and its Design, by H. Boyd Brydon, 48 pages; Price 25 cents postpaid.

General Instructions for Meteor Observing, by Peter M. Millman, 18 pages; Price 10 cents postpaid.

Two Inexpensive Drives for Small Telescopes, by H. Boyd Brydon, 12 pages; Price 10 cents postpaid.

A. H. Young's Simple Mounting for the 6-inch Reflector, by H. Boyd Brydon, 16 pages; Price 10 cents postpaid.

Send Money Order to 198 College St., Toronto.